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**DYNAMIC MICRO-MACRO MARKET COORDINATION AND TECHNICAL CHANGE**

by Gunnar Eliasson

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## ABSTRACT

This paper discusses the nature of macro productivity change from the perspective of a Schumpeterian micro-to-macro (M-M) model. It emphasizes the dynamics of resource allocation through markets (firms) where agents are both price and quantity setters. We find that the organization of market processes (the market regime) is important for the rate of total factor productivity change at aggregate levels. This is especially so when relative prices are shifty as a consequence of the ongoing market process and markets, notably the capital markets, are in disequilibrium.

Illustrative simulations on the M-M model of the Swedish economy are presented. The effects of shifts in the nature of technical change from a labor saving toward a capital saving bias are investigated in a semi-closed economy and in a fully open economy. In the latter exports adjust to the relative profitability of foreign and domestic deliveries and price transmission across borders occurs. We find that the allocation effects from effective exploitation of technical change through international specialization matter significantly for productivity growth. If the economy is kept semi-closed the same (exogenous) technical advance generates significantly smaller productivity expansion. The analysis suggests that the "mystic" residual shift factor in macro production function analysis that persisted for such a long time and then disappeard in a "mystic" way may partly or wholly be explained by a shift into a different "market regime" in the 70s among the OECD nations.

In all scenarios reasonable price and quantity flexibility prevent long-term technological unemployment from occurring. A change in the bias of technical change makes little difference.

# 1 THE MICRO DYNAMICS OF ALLOCATION - INTRODUCTION

Economic theory lacks a comprehensive theory of dynamic market processes. Received theory analyzes how existing resources are allocated among existing economic structures in a one period context and with exogenously given prices. The interesting problem is how markets influence the behavior of both prices and quantities over time. According to the structure and the adjustment process characterizing a market regime, relative prices are derived which bias the rate and direction of capital investment. We are interested in this latter influence of changing relative prices in a disequilibrium market adjustment process upon the allocation of capital and the production decisions. Such a dynamic economic framework is necessary to analyze a macroeconomic growth process.

Shifts in the macro production function has long been the key notion of technical change in economic growth. Empirical inquiries into the nature of this macroeconomic shift leaves most of the growth generating factors to be explained as a mystic residual, to paraphrase Denison. The residual is either represented by an exogenous trend, or by exogenous quality improvement in factors of production.

In my first paper (E 1985) I investigated the nature of accumulated capital. I found that much of capital accumulation - and probably the most important part - was of a "soft", non-process oriented kind. This finding led me to express doubts about the usefulness of the traditional macro production function analysis.

In this paper we study the quantitative importance of the allocation of capital through a dynamic market process. We abstract from the non-process capital and concentrate on the hardware factory production capital. We do, however, apply two observations from the earlier paper. The first observation is the tendency toward a relatively more capital saving technological change. The second observation is that R&D spending, an "investment" charged on current account, drives this shift in technological change. In addition the average character of capital installed is changing through exit of obsolete activities. We study the implications of this observation in a micro-based macro (M-M) model of the Swedish economy, where aggregation is made endogenous through a dynamic market process.

We carry on the analysis in three steps. First, we present a simple, semi-analytical version of the model where the rates of return and the capital market interaction of individual firms are made analytically explicit and related to the components of total factor productivity change. We draw on earlier empirical studies with the M-M model to clarify the mechanisms of the market system. This takes up the bulk of the paper.

Second (in Section 5), we carry out one set of simulation experiments where technical change is pivoted in a relatively more capital saving direction. In those experiments domestic markets are kept partly isolated from foreign markets (through exogenization of exports), thus depriving the firms in the economy of the possibilities of exploiting their technical advantages through international specialization. We then make domestic and international markets fully interactive.

We finally conclude with a section on policy making in the non-equilibrium market environment that we investigate.

In attempting to explain total factor productivity growth we have applied micro simulation analysis with the M-M model of the Swedish economy. In the M-M model analysis, relevant factor and product prices are endogenized and dependent on the factor and investment allocation process itself. There is a feedback relationship between relative prices and capital investment which determines the dynamic patterns of output growth.

The hypothesis is that the dynamics of realtive price adjustment matters significantly as an explanation to residual total factor productivity (TFP) change at industry levels. At least 50 percent of measured growth in all industry TFP appears to originate in the market induced resource allocation between firms and between divisions (or profit centers) in large firms. Hence, variations in market conditions, pure technical change at the micro level held constant, significantly influence long-term economic growth. (50 year macroeconomic growth trajectories differing by 1 or 2 percent per annum have, in fact, been generated by simply manipulating the market conditions and adjustment speed determining parameters of the M-M model.)

The M-M approach makes the dynamic market processes the moving force behind the rate of change in total factor productivity at the macro level. Manipulation of market regime controlling parameters can eliminate the macro growth effects of pure technical change at the micro level or enhance them. Pure technical change at the micro level sets the upper limits at each point in time for what can be achieved at the macro level through efficient economizing and, hence, is a necessary (and as a rule internationally available) condition. Given the technical parameters of the model and prices, maximum outputs could be calculated over a period. However, even though this would be the technical maximum of a static optimization exercise, it will never be reached, since the closer to the "technical optimum" you get, the stronger and speedier price feedbacks from further quantity approaches to the technical optimum, and the more jittery prices and the less predictable both short-term and long-term price development. Reduced predictability and increased economic uncertainty moves the economy away from the technical optimum.

(Hence, total factor productivity change or the "technical residual" seems to be a typically economic phenomenon. As a consequence, this paper also underscores the detrimental effects on economic growth of a disturbed or unpredictable market price system.)

## 2 MARKET REGIME AND TOTAL FACTOR PRODUCTIVITY GROWTH

### a) Technological and Market Regimes - the Problem

Three aspects of the macroeconomic process have to be made explicit to understand the nature of dynamic resource allocation and the economic growth process.

(1) Technology
(2) Macro demand control
(3) Market regime.

Technology is decisive for long-run cost developments. The marginally best producers in an economy compete market prices down toward their marginal costs.

Macro demand control is the Keynesian income generated demand feedback loop in a macroeconomy, through which the public sector may exercise a macro influence via intervention in both the income formation process (taxes), demand formation (government spending) and price formation (regulation). The market regime defines all other characteristics of the economy, institutional facts, the rules of the market game, and above all, the adjustment speeds of various actors to economic stimuli, notably prices.

The public sector through its legislative power exercises an influence on the market regime.

It is clear from this presentation that to discriminate between the impact on total factor productivity change of the market and of technology is not all that easy.

The macro demand feedback influences the short-term cyclical efficiency characteristics of the economy. Market regime together with the cyclical factors determine the long-run equilibrium characteristics of the economy. In the simulation experiments on the M-M model of the Swedish economy to follow, the nature of the divergence between long-run technology dependent costs and prices will be seen to be decisive for economic growth. In fact, we will find that technology, productivity and costs - as the latter determine long-run price developments - cannot be studied separately from the price mechanism itself.

In this paper we will attempt a complete micro-macro approach to the determinants of technical change and growth in which the dynamic market process and technical change are interdependent.

Of course, as one moves up in levels of aggregation eventually everything will have to be endogenously determined. We stop at the Swedish national borders. We make the doubtful assumption that the world is in long-run price-cost equilibrium. This assumption is implemented by adjusting exogenous foreign prices, the foreign interest rate and internationally available technology (best practice plants) in such a fashion that investments in such plants operating at full (normal) capacity will earn a return to investment equal to the foreign interest (these assumptions are explained in necessary detail in E 1983a). While the world is continuously in perfect equilibrium we study the dynamics and growth of a domestic M-M economy that is continually interacting with this "calibrated" world economy.

(We investigate the effects of (a) faster and slower rates of labor saving technical change through endogenous investments in existing firms (using different assumptions on the speed of agent responses in the markets) and (b) a more or less open economy. Technical change takes place in one firm, in one sector, or throughout the entire industry, or abroad only. We shift the character of technical change from a labor saving bias toward a technical saving bias (relative to a reference case).)

We will begin by briefly outlining the model, and making the capital market interaction and total factor productivity change explicit and related.

### b) The M-M-Model Economy[1]

Model Overview[2]

The M-M model is oriented mainly toward analyzing industrial growth. Therefore, the manufacturing sector is the most detailed in the model. Manufacturing is divided into four industries (raw material processing, semi-manufactures, durable goods manufacturing, and manufacture of consumer nondurables). Each industry consists of a number

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[1] Also called the MOSES model. Both the micro-macro model used and the experimental designs are too complex to be fully described in this paper. For more detail, we have to refer the reader to other publications (E 1976b, 1978a, 1983c, Albrecht-Lindberg 1982, Bergholm 1983).

[2] This "Model overview" paragraph is a slightly modified version of Bo Carlsson's presentation in "Industrial Subsidies in Sweden: Simulations on a Micro-to-Macro Model", in Microeconometrics, IUI Yearbook 1982-1983, Stockholm, 1983.

of firms, some of which are real (with data supplied mainly through an annual survey) and some of which are synthetic. Together, the synthetic firms in each industry make up the differences between the real firms and the industry totals in the national accounts. The 150 real firms in the model cover 70-75 percent of industrial employment and production in the base year, 1976. The model is based on a quarterly time specification.

Firms in the model constitute short and long-run planning systems for production and investment. Each quarter they decide on their desired production, employment and investment. Armed with these plans they go into the labor market where their employment plans confront those of other firms as well as labor supply. The labor force is treated as homogeneous in the model, i.e. labor is recruited from a common "pool". However, labor can also be recruited from other firms. This process determines the wage level, which is thus endogenous in the model. Even though the labor market is homogeneous, wages vary among both firms and industries without any tendency to converge. Since the labor market is only subdivided into industries, not regions, mobility in the labor market is probably overestimated. This is important in interpreting the results.

The micro-to-macro model features an endogenous firm exit device. It is activated when net worth of a firm goes below a certain minimum level in percent of total assets (bankruptcy) and/or when the firm runs out of cash (liquidity crisis). The firm, of course, gradually fades away through lack of investment if its cash flow diminishes and if it cannot borrow in the capital market at the going interest rate.

Domestic product prices and the production volume in the four product markets are determined through a similar process. The export volume is determined endogenously in the following way.

Each quarter the firms determine their production volume in two steps. First, they determine their desired production volume, taking into account desired changes in their inventories of finished goods, based on their expected total sales (including exports) which are in turn based on the firms' historical experience. This first production plan is revised by the firms with regard to profit targets, capacity utilization, and the expected labor market situation. After this revision, the production plan is executed. The production volume is distributed to the export and domestic markets according to an export share, which is dependent on that for the previous quarter, but which also depends on the differece during the previous quarter between the export price and the domestic price. If this export price (which is exogenous) was higher than the domestic price, the firms try to increase their export share during the present quarter. However, the adjustment takes place over several quarters, not instantly. If the export price is lower than the domestic price, the firms do not try to lower their export share but rather maintain it at a constant level. In spite of this asymmetry concerning the effect of positive or negative price differences between exports and the domestic market, it turns out that the export shares in the various markets can both increase and decrease. This depends on whether firms with high export shares fare better or worse than other firms in the market. The import share in the four markets is also determined by the difference between the export and domestic prices with a certain time delay. High domestic prices relative to foreign prices lead to increasing import shares.

There is also a capital market in the model where firms compete for investment resources and where the rate of interest is determined. However, in the present runs the rate of interest has been determined exogenously. At this given interest rate firms invest as much as they find it profitable to invest, given their profit targets.

Public sector employment is determined exogenously, and the rate of wage increase in the public sector has been set equal to the average wage change in manufacturing, preserving the relative, average salary and wage differential between the two sectors.

The exogenous variables (besides government policies) which drive the model are the rate of technical change (which is specific to each sector and raises the labor productivity associated with new, best practice investment in each firm), the rate of change of prices in the export markets, and the labor supply.

In contrast to most econometric macro models, domestic prices and wages are determined endogenously in MOSES. These in turn influence the firms' profits and therefore their production plans, the allocation of sales to the domestic and export markets, their investments, and therefore their productivity. This is the main mechanism through which resource allocation is determined in the model. These features make the model especially suited for analyzing the effects of policy measures, which can be expected to influence the expectations and plans of firms and which influence the development of prices and wages. The advantage of a micro-based simulation model is, that one can introduce various policy measures affecting individual firms, rather than industries and analyze the effects. In a more traditional macro model one is usually forced to make assumptions regarding the resource allocation effects, i.e. one has to assume a large portion of the results.

## Profits and the Allocation of Capital in the M-M Economy

To outline the capital market dynamics of the M-M economy we derive the profit targeting and profit monitoring formulae used for both production and investment decisions. It guides the firm in its gradient search for a rate of return in excess of the market loan rate. To derive these formulae we decompose total costs of a business firm, over a one year planning horizon, into:

$$TC = wL + p^I \cdot I + (r + \rho - \frac{\Delta p^k}{p^k}) \; p^k \cdot \bar{K} \qquad (1)$$

$w$ = wage cost per unit of L
$L$ = unit of labor input
$p^I$ = input price (other than w and $p^k$) per unit of I
$I$ = units of input
$r$ = interest rate
$\rho$ = depreciation factor on $K = p^k \bar{K}$
$p^k$ = capital goods price, market or cost
$\bar{K}$ = units of capital installed

In principle the various factors $(L, I, \bar{K})$ within a firm can be organized differently, yet achieving the same total output.[1] Depending upon the nature of this allocation the firm experiences higher or lower capital and labor productivity, as defined and measured below. In what follows we investigate the capital-labor mix as it is achieved through the dynamic market allocation of resources between firms.

The firm is selling a volume of products ($\bar{S}$) at a price $p^x$ ($S = p^x \cdot \bar{S}$) such that there is a surplus revenue, $\varepsilon$, over costs, or profit:

$$\varepsilon = p^* \cdot \bar{S} - TC \tag{2}$$

The profit per unit of capital is the rate of return[2] on capital in excess of the loan rate:

$$\frac{\varepsilon}{K} = R^N - r \tag{3}$$

In this formal exercise K has been valued at current reproduction costs, meaning that $\varepsilon/K$ expresses a real excess return over the loan rate, but that r is a nominal interest rate.

In the MOSES M-M model firm owners and top management control the firm by applying targets on $R^{EN}$, the return on equity-capital. This is the same as to say that they apply profit targets in terms of $\varepsilon$. Hence, we have established a direct connection

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[1] Note that the same formula appeared as (1) in my first paper (E 1985) when discussing resource allocation and use within one firm.

[2] The rate of return is then defined as

$$R^N = \frac{p^x \cdot \bar{S} - TC + r \cdot K}{K}$$

between the goal (target) structure of the firm and its operating characteristics in terms of its various cost items.

Using (1), (2), and (3) the fundamental control function of a MOSES firm then can be derived as[1]:

$$R^{EN} = M \cdot \alpha - \rho + \frac{\Delta p^k}{p^k} + \varepsilon \cdot \phi = R^N + \varepsilon \cdot \phi \qquad (4)$$

$$M = 1 - \frac{w}{p^x} \cdot \frac{1}{\beta} \qquad (5)$$

M = the gross profit margin, i.e., value added less wage costs in percent of S

$R^{EN}$ = $(P^* \bar{S} - TC)/E$ the nominal return to net worth ($E$ = K-debt)

$\alpha = \bar{S}/\bar{K}$

$\beta = \bar{S}/L$

$\phi$ = Debt/E = K-E/E

$\varepsilon = (R^N - r)K$

Management of the firm delegates responsibility over the operating departments through (4) and appropriate short-term targets on M (production control) and long-term targets on $\varepsilon$, that control the investment decision.

$\varepsilon \cdot \phi$ defines the contribution to overall firm profit performance from the financing department.

At any given set of expectations on $(w, p^x)$ in (4) determined through individual firm adaptive error

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[1] For proof of (4) and (5), see Eliasson (1976a, 1984c).

learning functions, a target on M means a labor productivity target on $\bar{S}/L$. Hence, the profit margin can be viewed as a price weighted and "inverted" labor productivity measure.

The $\varepsilon$ of an individual firm is generated through innovative technical improvements at the firm level (Schumpeterian innovative rents) that constitute Wicksellian type capital market disequilibria defined at the micro level. The $\varepsilon$ drives the rate of investment spending of the individual firm. The standard notion of a capital market equilibrium is that of all $\varepsilon_i=0$.

A new investment vintage can be regarded as a "new firm" with exogenous capital productivity ($\alpha=\bar{S}/\bar{K}$) and labor productivity ($\beta=\bar{S}/L$) characteristics. A new investment can be seen as a new vintage of capital with its particular ($\alpha,\beta,\rho$) characteristics in the profit control function (4) that mixes with existing capital installations in existing firms.[1]

Actual prices ($p^x$, $p^I$, $p^k$, w, r), which are distinguished from those expected by a firm in planning, are determined through the dynamic interaction of all agents in product, labor and capital markets.[2]

Foreign prices in four manufacturing product markets, technical change in new investment vintages and the foreign interest rate are set exogenously.

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[1] In a fashion described in Eliasson (1978, p. 63ff).

[2] Only manufacturing firms are modeled in micro. The rest of the economy is closed through an eleven sector Leontief-Keynesian macro model.

Firms set prices and quantities and compete freely in all markets, thereby competing Schumpeterian innovative rents $\varepsilon$ away for each other, if they cannot be maintained through some innovative process, that generates new $\varepsilon$:s all the time. Part of competition takes place in the capital market, where high $\varepsilon$ performers attract relatively more funds than low performers. This process can be said to be a long-term micro version of Wicksell's (1898) "cumulative process", at the time regarded as an inflation theory (see E 1984a).

A firm exits permanently when it has suffered losses to the extent that its net worth $E < 0$. Firms also compete with each other and with other sectors for a given pool of labor. In the process individual firm wage levels and unemployment are determined and labor is distributed over firms. There is a similar short-term production and product price determining market mechanism. (All this is described in detail in E 1976b, 1978a, 1983b, and 1984a.) This more or less outlines the capital market dynamics of the MOSES M-M model. The dynamically ordered micro market economy that we are investigating is an economic system "with memory" which makes all states achieved "path dependent". (A system like this possesses an equilibrium if and only if all feasible future paths can be foreseen and the best chosen. This, however, requires an objective (welfare) function, that translates all feasible futures into the present, or that the capital market stays in equilibrium all the time. A capital market in equilibrium with all $\varepsilon_i=0$, however, reduces the choice, at best, to (see below) a no growth economy (also see E1983a).)

When "monopolistic competition" is a natural market regime characteristic and prices and quantities are set in an interactive fashion as a part of an ongoing market process, a number of questions arise as to the nature of macro productivity change, and especially the relationship between profitability and total factor productivity growth. These will now be investigated.

### c) **Total Factor Productivity Change Derived**

Total factor productivity (TFP) change is defined as the shift factor in a macro production function. Its behavior at the macro level has been studied extensively. In this paragraph we define TFP in terms of the profit control function of a firm in the Swedish M-M model. In the next section we carry on certain simulations to study the behavior of TFP under various assumptions as to technical change that enter as changes in the productivity parameters ($\alpha,\beta$) in (4) and (5) of new investment vintages.[1]

This section is theoretical. The next section is empirical in the sense that the same problem - the effects on output and productivity of the dynamics of factor allocation - is investigated on the M-M model of the Swedish economy. This section aims at introducing the dynamics of the model through the eyes of neoclassical macro production function analysis. Before we do that a few explanatory words of why we do it are in place. The heart of the matter is that a model based on exogenous

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[1] In the standard MOSES description $\alpha \cong$INVEFF, $\beta \cong$MTEC. See E 1978a, Sections 4.3 and 4.4.

prices and equilibrium conditions - to my mind - gives an erroneous representation of macro production activity and productivity change. It is not even an acceptable approximation in this context because there is no room for the dynamic long-run productivity effects of price-quantity interaction over time. Since the macro production function passes standard econometric tests on its own merits the only way to challenge it is to present an alternative theory that is compatible with a standard macro production function under certain circumstances. We will demonstrate that the other circumstances are the normal state of the economy and that they give rise to very different interpretations of productivity change. This is enough to present our case, even though we have not been able to do all the illustrative simulations and estimations that we might have wished.

The gist of my argument relates to the measurement system and the priors you are willing to accept in your analysis. We argue that the M-M model is richer in empirical content than the macro model, and contains reasonable behavioral specifications. If small modifications in the M-M model - that are prior and concealed assumptions in the macro model - give rise to widely diverging macro interpretations, we have a case against the macro analysis in at least the particular cases to be expounded below. The key objection has to do with the aggregation assumptions of exogenous, equilibrium prices, which remove the productivity effects of dynamic factor market allocation. There is so to speak no dual because there is no equilibrium. We will illustrate in the next section through inter alia closing and opening up the productivity potential of international specialization.

<u>Definition of change in macro TFP - where does technology enter?</u>

Define TFP as deflated value added (Q) divided by deflated total cost:

$$TFP = \frac{Q}{\text{Deflated TC}} \tag{6}$$

In what follows we abstract from all purchases of intermediate goods and services and fluctuations in finished goods inventories. Hence, deflated value added is identical to sales volume:

$$Q = \bar{S}$$

Introduce the implicit factor price deflator such that (from 1):

$$TC = \xi X$$

and

$$\text{Deflated TC} = X$$

Then introduce:

$$\frac{\Delta TFP}{TFP} = \frac{\Delta Q}{Q} - \frac{\Delta X}{X}$$

It follows:

$$\frac{\Delta TFP}{TFP} = \frac{\Delta Q}{Q} - \left(v_1 \cdot \frac{\Delta L}{L} + v_2 \cdot \frac{\Delta \bar{K}}{\bar{K}}\right) \tag{7}$$

where: $v_1 + v_2 = 1$

$$v_1 = \frac{wL}{\xi X}$$

$$v_2 = \frac{(r+\rho-\Delta p^k/p^k)p^k \cdot \bar{K}}{\xi \cdot X}$$

Output growth can now be expressed as:

$$\frac{\Delta Q}{Q} = s_1 \cdot \frac{\Delta L}{L} + s_2 \frac{\Delta \bar{K}}{K} + s_3 \cdot \frac{\Delta \bar{\varepsilon}}{\bar{\varepsilon}} \tag{8}$$

where: $s_1 + s_2 + s_3 = 1$

$$s_1 = \frac{wL}{p^q \cdot Q}$$

$$s_2 = \frac{(r+\rho - \Delta p^k/p^k)p^k\bar{K}}{p^q \cdot Q}$$

$$s_3 = \frac{\bar{\varepsilon}}{p^q \cdot Q}$$

$(v_i)$ and $(s_i)$ are weights in the price indices $(\xi, p^q)$ used to deflate TC in (1) and value added. $\bar{\varepsilon}$ is the deflated $\varepsilon$ in (2). $\bar{\varepsilon}$ is again the dynamic factor that represents the capital market disequilibrium and that moves the investment of the individual firm. If $(s_i)$ can be assumed to be constants, the integral of (8) is:

$$Q = AL^{s_1} \cdot \bar{K}^{s_2} \cdot \bar{\varepsilon}^{s_3} \tag{8B}$$

For this integral to exist we have to assume $\varepsilon \neq 0$ which is the same as to assume that the capital market has to be in disequilibrum in a Wicksellian sense ⌊E 1984a⌋. If we can assume that $R^N$ and r in (3) should be corrected by the same deflator then monetary equilibrium means real equilibrium and vice versa. However, the way we deflate $\varepsilon$ means something for productivity change as we measure it.

## TFP and Stability of Relative Prices

The existence of a capital market disequilibrium required for the existence of (8B), hence, is partly a matter of accounting principles and partly a question of how factors are paid. If product and labor markets are in equilibrium and if the capital market is continuously in equilibrium in the Wicksellian sense of all $\varepsilon_i$=0, there can be no technical change except for accounting reasons.

Relationships such as (8B) have frequently been estimated under the name of production functions. To explain this let me repeat the earlier argument backwards. A macro production function like (8B) usually assumes labor and investment goods markets to be in equilibrium. L and K are assumed to fetch their marginal product at each point in time. Expectations are static, so at each point in time the steady technical shift comes as a complete surprise, that nevertheless does not disturb prices (by assumption) and the continuing equilibria in capital and investment goods markets.

Who makes the production function shift? Suppose it is the owners of the production function outfit (8B). Then they pick up the residual value generated which ex definione defines their marginal contribution. All markets, including also the equity market, are in static equilibrium. A dual exists. This is all fine as long as you don't attempt to measure the owners' contribution with the $\varepsilon$ in (2), or to correct the K value with $\varepsilon$, and then estimate the production function. You then have an identity and your estimation is likely to break down, if you don't apply some tricks. However, my point of argument has been that if you estimate an (8B) type production function on data for a world where (L,K) markets are in equilibrium then the estimated shift factor picks up the value added contributions of non (L,K) factors, and this contribution is equal to what non (L,K) factors get paid, presumably "the owners". However, again if (L,K) markets are not in equilibrium then the shift factor in fact picks up whatever factors (L,K) have been over or underpaid relative to their marginal productivities. If this is the normal state, which we argue is the case, then the estimated shift factor is only partly technological. It in fact averages exactly to what we have demonstrated, namely the residual remuneration to owners. Even worse, suppose labor is in a strong bargaining position and anticipates the steady, value added contribution from technical change in the form of higher wages, then much, or all of the technical shift factor may disappear as statistically estimated, even though it has in fact been there.

Sometimes these underlying "financial assumptions" have been discussed or even been made explicit. Thus, for instance, Åberg (1984) in estimating (8B) type production functions on data from OECD countries assumes a constant loan rate and a constant rate of return at the macro level for his various industries, when they are operating at normal capacity. This is the same as assuming that the aggregate $\varepsilon$ for an industry is constant over time, which has also been true for Swedish manufacturing at a sufficiently high level of aggregation for the postwar period up to the mid-70s.

There is, however, also the matter of micro and macro. If relative prices are changing then instabilities in $(s_i)$ should be expected together with a continuous turnover of $\bar{\varepsilon}$ over time and across firms. We obviously have a problem with the macro production function when the supply side of the economy is subjected to reallocation of resources induced by relative price changes, as during the 70s. Indeed, in the MOSES M-M economy such dynamic resource reallocation is the main vehicle for productivity change. Furthermore, $\{\bar{\varepsilon}\}$ is also unstable, and different across firms, due to changes in interest rates in the financial market contributing to changes in TFP.

We know that for one firm:

$$s_1 = v_1 \cdot \frac{\xi \cdot X}{p^q \cdot Q}$$

$$s_2 = v_2 \cdot \frac{\xi \cdot X}{p^q \cdot Q}$$

It follows that:

$$\frac{\Delta TFP}{TFP} = \frac{\Delta Q}{Q} - \frac{\Delta X}{X} = \left[1 - \frac{p^q Q}{\xi \cdot X}\right] \frac{\Delta Q}{Q} + s_3 \frac{p^q Q}{\xi \cdot X} \cdot \frac{\Delta \bar{\varepsilon}}{\bar{\varepsilon}} \qquad (9)$$

or, slightly rewritten as:

$$\frac{\Delta TFP}{TFP} = \frac{\Delta Q}{Q} - TFP \cdot \frac{p^q}{\xi} \left(s_3 \cdot \frac{\Delta \bar{\varepsilon}}{\bar{\varepsilon}} - \frac{\Delta Q}{Q}\right) \qquad (9B)$$

Consequently, total factor productivity change depends critically on how we have defined our price indices $(p^q, \xi)$ to calculate Q and X and hence also $\bar{\varepsilon}$.

Using the M-M model it is possible to simulate the dynamics of TFP change and assess the impact of different price deflators, market conditions, and rates of technical change in new investment vintages.

Before exploring these model experiments we will discuss further some implications of TFP change as defined by (9) and (9B).

Since $\Delta TFP/TFP$ will mainly reflect the movements of average $\varepsilon$ and the stability of the $\bar{\varepsilon}$ distribution over time and over firms, it would be more in keeping with the MOSES M-M concept to relate distributional $\bar{\varepsilon}$ properties and output growth. This has been done to some extent in (E 1984a), and the results strongly emphasize the importance for long-term, stable growth in output, of a continuous turnover of Schumpeterian rents, thorugh innovative entry, innovations within firms and a steady exit flow of low performers, i.e., of a maintained capital market disequilibrium.

To begin with the shifting of the production function, defined by

$$\frac{\Delta TFP}{TFP}$$

partly reflects how the relative price vector ($p$, $p^I, w, r, p^k$) has been defined and calculated, most notably the interest rate $r$, and partly on how the weights $v_i$ and $s_i$ have been choosen.

A direct relationship between total factor productivity change and $\varepsilon$ (the difference between the return to capital and the loan rate) has been established, when $\varepsilon$ has been deflated (to $\bar{\varepsilon}$) by some choosen price index. The profit minded entrepreneur is, however, interested in the current value of $\varepsilon$, and the current and constant price $\varepsilon$ and $\bar{\varepsilon}$, respectively, will move apart if prices change.

If $v_i$ and $s_i$ are fixed to a given base period, type of price index has been chosen. Then only shifts in real factor use coefficients ($\bar{S}/L$, $\bar{S}/I$, $\bar{S}/\bar{K}$) will affect total factor productivity change.

If the base period for the price indexes, on the other hand, is changed we lose conceptual control of TFP-change. If we use a continuously adjusted base period for the deflators, relative price change affects the size of TFP-change. It is easy to understand that a considerable literature on the index problem in production function analysis exists (see e.g. Diewert 1976, Fisher 1965, 1969, 1982, Griliches-Jorgenson 1967 or Brown-Greenberg 1983). Such analysis, however, has only been done under the assumption of static, equilibrium conditions when prices can be thought of as exogenous.

In the context of a dynamic market economy where resource allocation is guided by endogenous market price signals, however, the $(s_1,s_2)$ as well as the $\varepsilon$ become jittery and aggregation functions begin to shift, because of shifting relative prices and mistaken expectations. This instability in the price weights of the aggregation functions surfaces "technically" in the form of total factor productivity change. This poses problems for statistical estimation of a production function, unless the change is random and stationary or with a definite trend.

In a first round of model experiments we will investigate what happens when the economy experiences a pivoting in the relative size of $(\alpha,\beta)$ as it appears in new investment vintages that are endogenously entered into existing firm capital structures through micro investment functions dependent upon $\varepsilon$.

Capital Market Equilibrium

An equally interesting question, however, relates to the setting of the capital market loan rates and how this affects both investment through $\varepsilon$, and $\Delta TFP/TFP$ directly through the accounting relationship (9B). In our experiments the market loan rates will be set exogenously. But in a fully market integrated simulation the possibility of departing from the foreign interest rate through domestic policies is severely limited. Even so the rate of return on total assets $R^N$ in (4) is not independent on the rate of interest in the capital market, since variations in the interest rate affect all other domestic prices $(p^q,w,p^I,...)$ in the economy, and hence the level and dispersion of rates of return across the firm population.

We observe from (9) that $\Delta TFP/TFP$ is defined if, and only if, $\bar{\varepsilon}\neq 0$. For $\Delta TFP/TFP$ to be not only well defined but non-zero it must further hold that $\Delta\varepsilon=0$.

A dispersion of $\bar{\varepsilon}_i\neq 0$ across the micro population of firms is a normal state in a dynamic market process. The position of individual firms in the distribution of $\varepsilon$ should also change over time (see E 1984a). [This "technically" means that total factor productivity change becomes an erratic phenomenon at the micro level.]

At the macro level total factor productivity change occurs as long as average $\bar{\varepsilon}>0$ across the firm population, assuming a given index pair $(\xi, p^q)$. We ask what happens when all agents in the market adjust such that $\bar{\varepsilon}_i \to 0$, $i=1,2,\ldots,n$. This is a puzzling question that we have not been able to explore analytically. Simulation experiments, however, indicate (E 1984a) that the macroeconomy gets unstable and collapse prone as the $\bar{\varepsilon}_i$ converge toward 0.

In the micro setting of our model economy the capital market should be in equilibrium where the marginally best producer with the highest $\bar{\varepsilon}$ determines the loan rate, making his $\bar{\varepsilon}=0$ and all other $\varepsilon<0$. As a consequence, all other producers will adjust their output through the investment process (guided by $\bar{\varepsilon}$) until their $\bar{\varepsilon}$ become = 0 and/or the corresponding adjusment of investment, labor demand and output will affect all prices to the same effect. However, then (8B) will not be defined.

Either a state where all $\bar{\varepsilon}_i=0$ does not exist, or it is impossible to reach even as a momentary state. In short, a steady state solution is not feasible in a dynamic micro-to-macro economy.

## The Cumulative Process by Schumpeter and Wicksell Combined

Let us, nevertheless, with Schumpeter, assume that we are in such a "Walrasian" equilibrium.

Assume, furthermore, that some "entrepreneurs" invent production methods that make it possible for them, at prices given by the previous technological state to earn a return $\bar{\varepsilon}>0$, and, hence to invest.

A distribution with some positive $\bar{\varepsilon}_i$ then appears, that normally generates an aggregate

$$\frac{\Delta TFP}{TFP} > 0$$

because of the equilibrium disturbing, "costless" innovations.

The positive $\{\bar{\varepsilon}_i\}$ sets economic forces in motion. Investment takes place. Demand for factors of production increases and factor prices increase making the $\bar{\varepsilon}$ of all non-innovating firms negative. Eventually these actors will exit or improve again through "costless" innovations, etc. This is in principle how the M-M model currently operates.

The interesting question for an evaluation of total factor productivity change observed at the macroeconomic level, then is whether a positive such change depends on a constantly maintained disequilibrium in factor markets, with constantly underpaid factors, including savers, and/or whether the growth process occurs because "costless" innovations keep generating positive $\bar{\varepsilon}$ at the micro level, that are constantly eroded through market induced factor price adjustments.

In what follows we will hence concentrate instead on studying the output effects of changes in the nature of technical advance at the micro level and/or the international market conditions.

## 3 THE MACROECONOMIC EFFECTS OF TECHNICAL CHANGE AT THE MICROECONOMIC LEVEL

Earlier technology experiments on the MOSES model economy have been concerned with exogenous advances in labor saving technique through changes in $\beta$ in (5), proportionally across all firms, in a sector or in one large firm only (E 1979, 1980). Three results from these experiments should be noted here. First, exogenous technical advances embodied in all new investment goods and brought into the production system through endogenous investment have to be activated by economic mechanisms to affect the macro economy. For instance, if firms keep investing because they have a large enough cash flow, they upgrade both the quality and the quantity of installed capacity. But there may be no output effects if demand is slack or if competition from other producers is slack. Hence, the lags between technological advances available in capital goods offered in the market may be short, long or very long depending upon the market conditions prevailing.

Second, for a given set of such exogenous, technological conditions (a "technical regime") we have been able to generate a wide spread of long growth cycles by simply varying the specifications of the "market regime", notably the speed of price-quantity adjustments. In particular, if we somehow manage to keep a wide margin between $R^N$ and r in (3) or a large $\varepsilon$, by exogenously lowering r, assuming that savers willingly let themselves be fooled to supply funds at a low interest rate, a Wicksellian inflationary process accompanied by an investment boom is set into motion (E 1984a).

Over 50 year quarterly simulation experiments we have generated industrial output expansion paths - holding technological regimes constant - diverging as much as those between the industrial nations during the past 50 years.

Third, finally, in a model economy with individual agents being both price and quantity setters simultaneously, long-term or permanent technological unempolyment is not a feasible phenomenon. Wages will eventually adjust to new technological circumstances, labor will move and unemployment will return to "normal". Permanent technological unemployment requires a Keynesian type fix price model. In a dynamic free market setting, the unemployment problem of interest has to do with the time dimension and the stability of the employment adjustment process. A very fast market regime (E 1983) after a technolgocial change generates continued unemployment through instabilities. A very slow market regime - even though stable - takes its time to reduce significant disequilibria. In particular, if initial "disequilibria" created are large enough the adjustment process may be erratic for quite a while.

In the model market regime that generates the best "macro fits" in historic simulations domestic, local technological changes, whether local or universal, only generate minor, local unemployment situations that disappear after a 2 to 5 year period (E 1979). Major disturbances associated, for instance, with clumsy economic policy making, that generate cost overshooting in export industries are more prone to create significant unemployment situations, however rarely of long duration because prices, notably real wages, adjust. Similarly, technological changes abroad, maninifested through intense price competition in foreign markets, in combination with a rigid wage and mobility structure in the domestic labor market easily creates serious unemployment spells in the entire export sector. The micro-to-macro market regime can be "enriched" by various kinds of price regulation arrangements that slow down or bias the adjustment response to technological competition, such that seemingly persistent unemployment and slow growth <u>may</u> follow. This is a hypothesis about the properties of the model economy that we have not analyzed further in this paper.

With these results in mind it is interesting to see if differences in outcome occur if we change the nature of technical advance. The popular notion would be that labor saving technical change creates unemployment, while capital saving technical change of the same "size" doesn't. I have found in my earlier paper (E 1985) that technical change currently may be shifting in a relatively more capital saving direction. Does the popularistic notion that we then have to worry less about technclogical unemployment hold up?

To begin with we have set two different technological scenarios against each other. In one scenario (the capital saving scenario) the capital output ratio in new investment vintages (INVEFF = $\alpha$ in (4)) increases one percent per year, compared to zero percent in the reference case. Labor productivity on the margin in new investment vintages (MTEC = $\beta$ in (5)) expands at the same rate as in the reference case. In the second, labor saving scenario, the capital output ratio in new investment vintages is the same as in the reference case (i.e., zero rate of change) while labor productivity associated with new investment vintages expands one percent faster per year than in the reference case. Everything else that can be controlled, including policy parameters, is kept unchanged.

In the first round of experiments (running 30 years by quarter) the foreign trade setting is "Keynesian". Individual firm exports are price inelastic, or exogenous and tied to a perceived market growth projection. In the second round of experiments the foreign trade setting will be classical and dynamic and more true to the MOSES idea. Relative competitive forces as reflected by domestic and foreign price and cost differentials will regulate the relative proportion of individual firm total supplies of goods in export markets. In this way market-induced international specialization made possible by the introduction of new techniques will define the differences between the two rounds of experiments.

The output effects on the margin of a "unit of technical change" are roughly comparable in the first years of the simulation. After a few years the experiment cannot be controlled in that respect. (This is a typical property of a dynamic simulation on MOSES with path dependent states, primarily because relative product and factor prices change endogenously.)

## a) Nature of Technical Change and Elasticity of Export Supplies - a Comparison

The first thing to notice is that the two experiments with price inelastic foreign supplies spin off different cyclical waves in output. (See

Figure 1.) After some 20 years, however, output in the capital saving technical scenario starts declining relatively, while the opposite happens in the price elastic export scenario. Relative wages (Figure 3) follow relative output growth, while total unemployment, or the unemployment rate (Figure 2) moves the opposite way. In the price elastic foreign trade regime, capital saving technical change (eventually) yields more output growth, higher wages and less unemployment. In the Keynesian (price inelastic) regime, the results are the opposite. Labor saving technical change generates superior results.

On the whole, however, the longer-run (30 years) differences are not that large. In the two Keynesian price inelastic scenarios less people work in manufacturing in the capital savings scenario because capital saving technical change has generated a larger cash flow, more investment, faster income and demand growth, and hence both more efficient production and a faster growth in overall capacity. (If the Government had opted for faster expansion most of the unemployed could have been absorbed by the public sector without jeopardizing economic growth.)

Terminal labor productivity in manufacturing is roughly the same in both Keynesian scenarios. A somewhat higher profitability has stimulated somewhat more investment in the capital savings scenario. Capacity to produce is larger but the result by the end of the simulation is more slack, in the form of unused labor and machinery capacity, rather than more output.

The M-M economic system does not recognize the existence of aggregate capital in the production process, but it can generate all kinds of capital aggregates according to desired specifications. All deflated aggregate capital output measures decrease, whether installed machine capacity (used in Figure 4B), actually used machine capacity or all assets are used in the numerator.[1] The same measures show no trend, if computed in current prices, signifying a relative price trend "in favor of" investment goods manufacturers. It is interesting to note that the fall is most significant in the price inelastic (Keynesian) export cases. For each market regime capital or labor saving technical change makes little difference. The reason appears to be that the Keynesian market regime is less favorable to all firms and force more frequent exits and contractions of large, hardware capital intensive firms, while in the capital saving scenario rates of return improve and even basic industries survive and/or grow.

### b) Total Factor Productivity Effects from International Specialization

Things began to happen when we released the effects of international specialization through opening up the economy to foreign competition. In the model technological knowledge is available as an exogenous resource vested in new investment goods. Innovative technical change at the micro level may be potentially favorable to the economy but the

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[1] The rapid initial drop in capital output ratios in Figure 4B, and particularly in the Keynesian experiments, depend on numerous exits of low profit, high capital output firms during the first few years of the simulation.

economy may be unable to respond by faster economic growth. The main transmission mechanism is the investment decision of individual firms. Absence of positive economic systems responses is typical of the "Keynesian" (export price inelastic) experiments which exclude a rapid exploitation of the new export opportunities through factor reallocations (labor and capital) within the domestic economy. The reason is the price inelasticity of export supplies assumed. The firms cannot expand profitable shipments abroad beyond what has been assumed about exogenous world income growth. Domestic performance, nevertheless, is fine, since firms are being subjected to free import competition. The internationally specialized Swedish model economy cannot, however, compensate for lack of access to profitable foreign markets through a shift in the direction of more volume production for the home market. Competition holds down domestic prices and growth, and domestic and foreign costs grow apart. This is reflected in a growing differential between foreign (assumed) and domestic (endogenous) prices.[1] With price and profit guided individual export shipments we expect to observe larger export shipments, and also a faster transmission of foreign prices into the Swedish economy. Compared to the price inelastic (Keynesian) case investment and labor resources should now be allocated (mixed) differently, and - we also expect - slack reduced. When seen from the aggregate industry level more economic growth should

[1] The reader should observe that the specialization effect only occurs among the marginally best producers in the micro-to-macro economy. The Keynesian assumptions mean protection from foreign competition. Firms can raise prices and increase profits while at the same time slack (or a deterioration in productive performance) accumulates. The marginally best producers in each sector take advantage of this.

occur through faster TFP growth, or a shifting of the macro production function. Let us now switch on the price elastic export supply functions.

The simulation results are those expected. Manufacturing output growth is increased because of a more efficient resource use by between 1/2 and 1 percent per annum over the 30 year scenario, depending upon which experiments we compute. For each technical change scenario the enhancement of TFP growth through trade specialization is reflected approximately by the differences in output growth curves. In Figure 1 (C and D curves)the index minus 100 approximates the cumulated size of the TFP effect from international specialization.[1]. As in earlier runs the difference is small to begin with but then the capital savings technical change scenario appears to yield the largest output effects from international trade specialization. In the beginning the direct effects of "technical changes" are almost equivalent. Then indirect feed back influences begin to cumulate and apparently these indirect effects are larger in the capital savings scenario.

The relatively faster growth in output and in TFP through trade specialization in the capital savings scenario is reflected also in a relatively faster increase in wages. The wage cost increases are, however, relatively smaller than the corresponding output and productivity effects (this can be seen from a comparison of Figures 1 and 2). There is, however (Figure 3) virtually no difference in employment effects because of the differences in technical change. This is what we would

[1] This is only approximately true since factor (labor and capital) use differs somewhat in the two scenarios.

expect from an economy characterized by a reasonably flexible price system, even though wage costs are (nominally) sticky downwards. However, openness to international trade specialization pays off in both technical scenarios in the form of faster employment growth and less unemployment. The reason is further output growth and wages lagging productivity growth.

It is interesting to note that the investment cycles generated are quite different (Figure 4) even though average investment volume is approximately the same. Opening up the economy to trade specialization generates one type of investment cycle (C&D) regardless of technical change. Changing from one kind of technical change to another generates another investment cycle (A&B) regardless of export regime.

Price flexibility seems to matter significantly for unemployment (Figure 3). When we move from a price inelastic to a price elastic export supply function, and participation in international trade increases, unemployment diminishes significantly.

With capital saving technical change price inelastic export supplies take unemployment on a long upward drift (Figure 3). With price elastic exports capital saving technical change brings unemployment down. The market regime seems to be what matters for employment, not the technological regime.

Exogenous public sector demand has been exactly the same in all simulations. Hence, this set of experiments for one thing illustrates the growth effects of more efficient resource use because of

**Figure 1 Manufacturing output**

Experiments with shift toward capital saving technical change (23, 27) or labor saving technical change (24, 28). Keynesian (A) and price elastic (B) exports.
(C) Exhibits output in capital savings technical change scenario; price elastic exports in percent of price inelastic exports.
(D) Same for labor saving technical change.

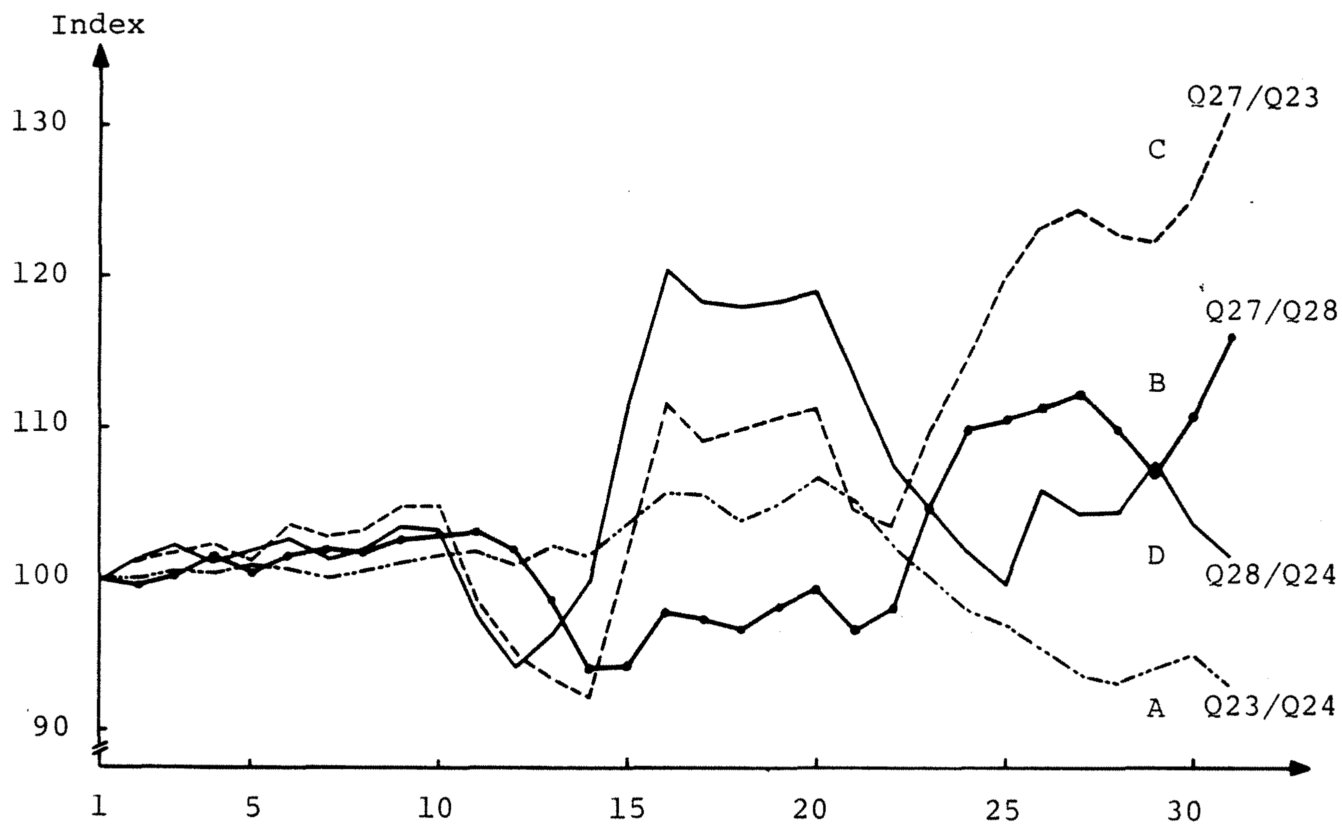


**Figure 2 Wage costs**

Experiment with shift toward capital saving technical change (23, 27) over labor saving technical change (24, 28). Keynesian (A) and price elastic (B) exports.
(C) Exhibits wage costs in capital savings technical change scenario; price elastic exports in percent of price inelastic exports.
(D) Same for labor savings technical change scenarios.

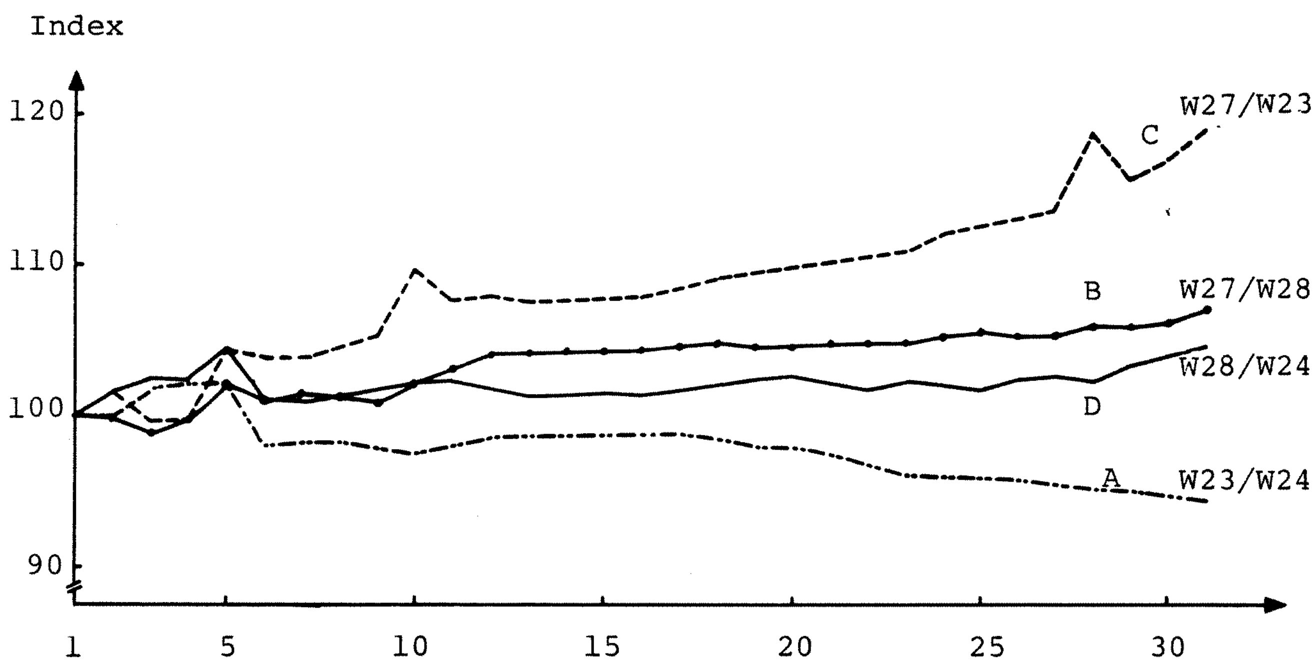


**Figure 3 Manufacturing unemployment**

Experiments with shift towards capital saving technical change (23, 27) over labor saving technical change (24, 28).
Keynesian (A) and price elastic (B) exports
(C) Exhibits unemployment in capital savings technical change scenarios; price elastic exports in percent of price inelastic exports.
(D) Same in labor savings technical change scenarios.

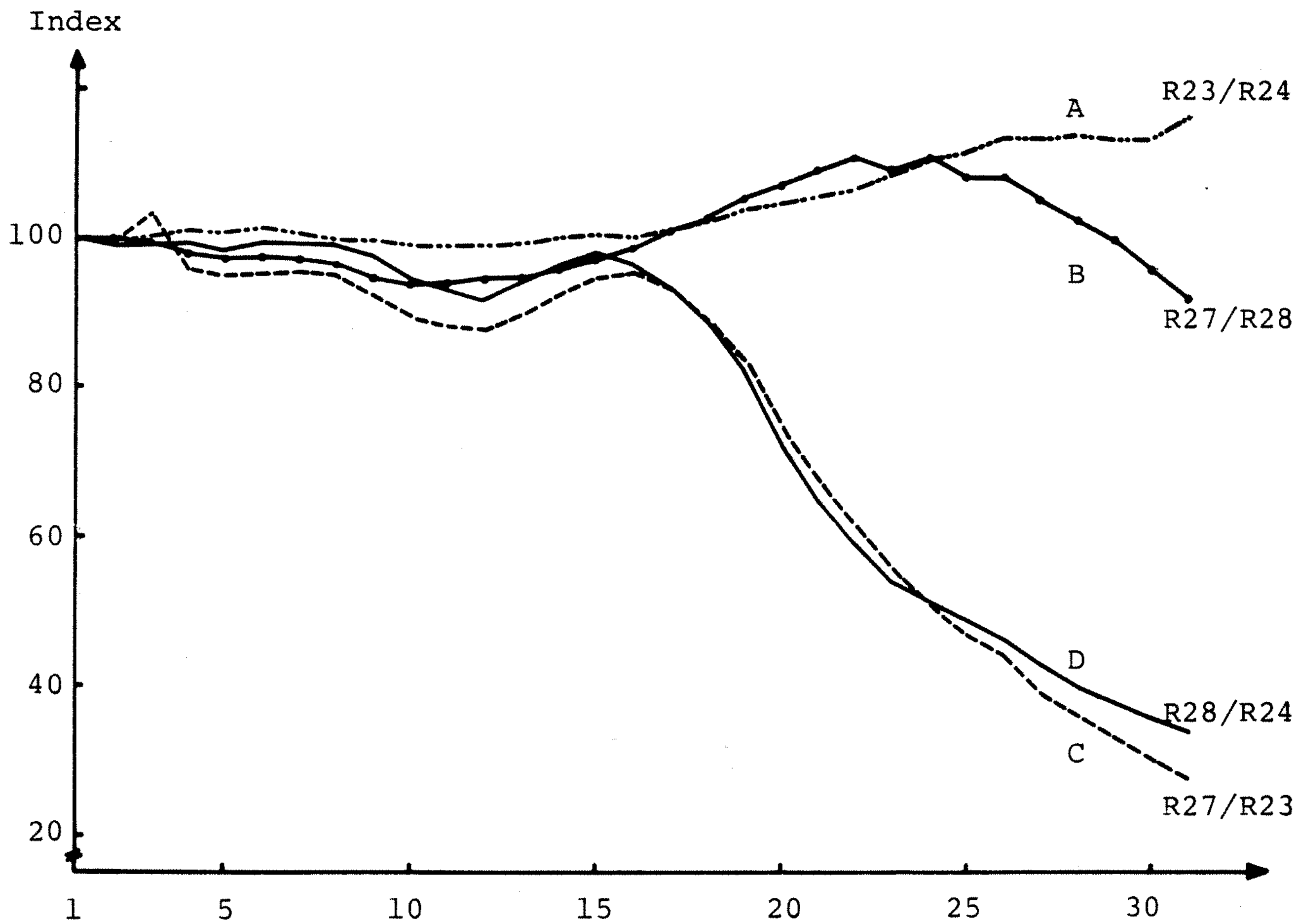


**Figure 4A Manufacturing investment**

Experiments with shift toward capital saving technical change (23, 27) over labor saving technical change (24, 28). Keynesian (A) and price elastic (B) exports.
(C) Exhibits investment in capital savings technical change scenarios; price elastic exports in percent of price inelastic exports.
(D) Same for labor saving technical change scenarios.

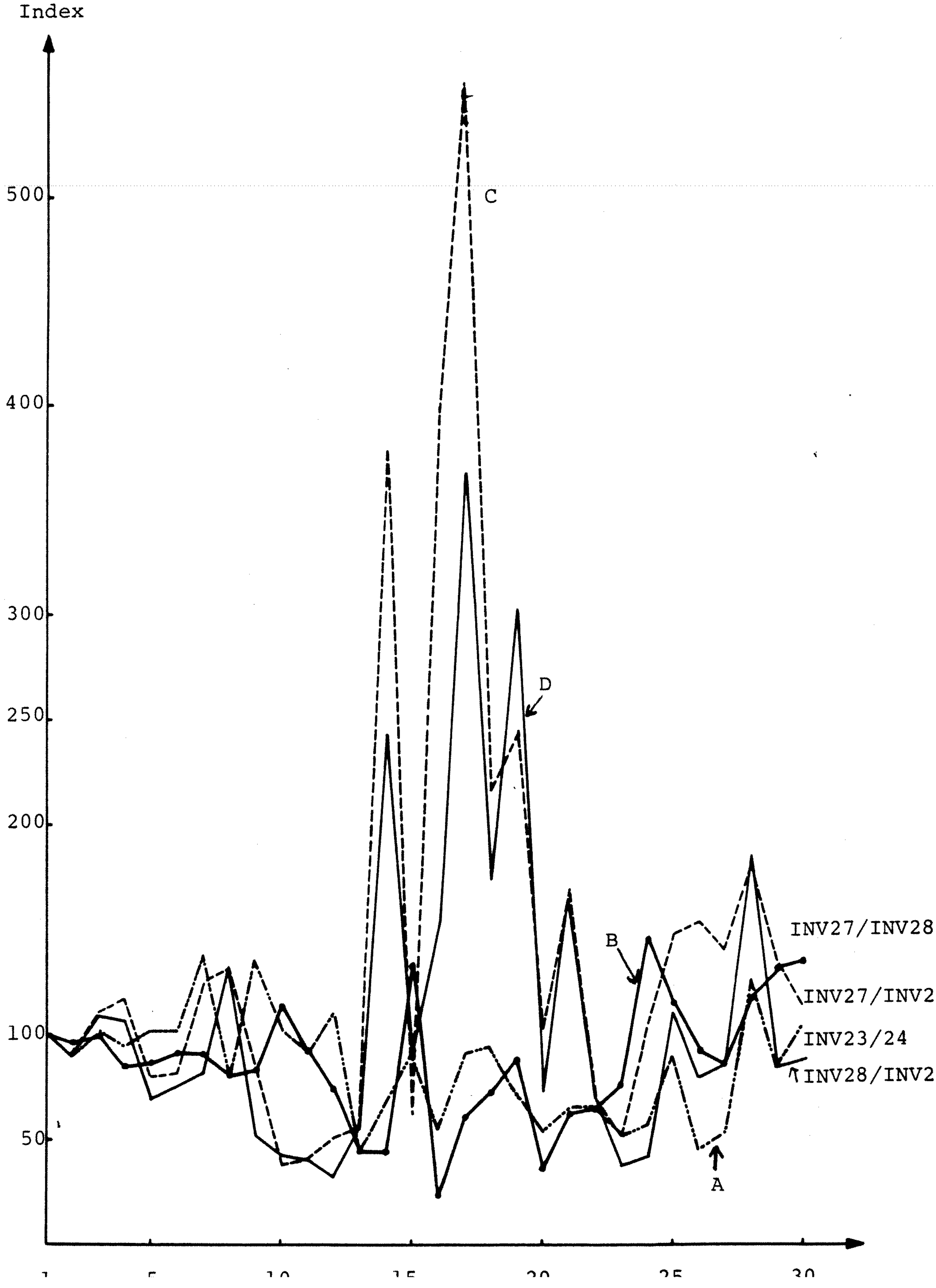
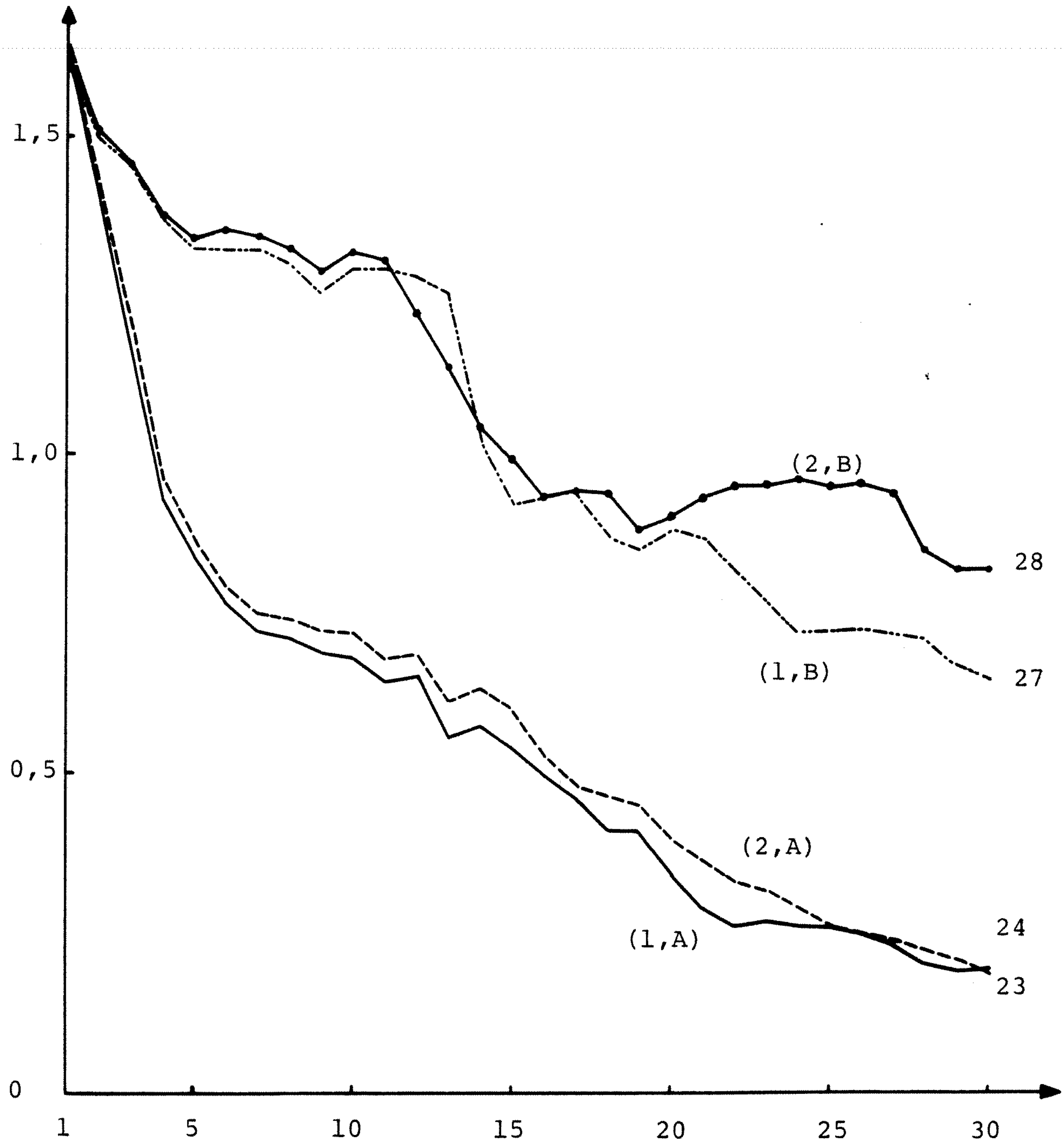


**Figure 4B Capital output ratios**

(1) capital saving technical change
(2) labor saving technical change
(A) price inelastic exports
(B) price elastic exports




Note: Capital has been computed by cumulating net price adjustment capital stocks, adding them across firms, and deflating by the implicit price deflator simulated for the investment goods market.

international production and trade specialization, and secondly that endogenously generated income and private demand growth through increased trade specialization can solve "the unemployment" problem alone, irrespective of the technical change characteristics assumed and without any support from tax or deficit finance of public demand expansion.

As a consequence of the foreign-domestic market interaction, the relatively higher fraction of supplies combined with import competition has forced up domestic prices closer to foreign prices. Consequently, output runs significantly higher than in the "closed" alternative, and machinery slack and labor hoarding much below.

The effects on output and employment of a pivoting of the direction of technical change comes out even more clearly in a more narrowly controlled experiment. In the reference case with price elastic (endogenous) individual firm export determination, that tracks actual macro behavior over a historic reference period quite well, capital saving technical change is zero, while labor saving technical change is set at 2.5 percent per annum on the average (at the firm level).

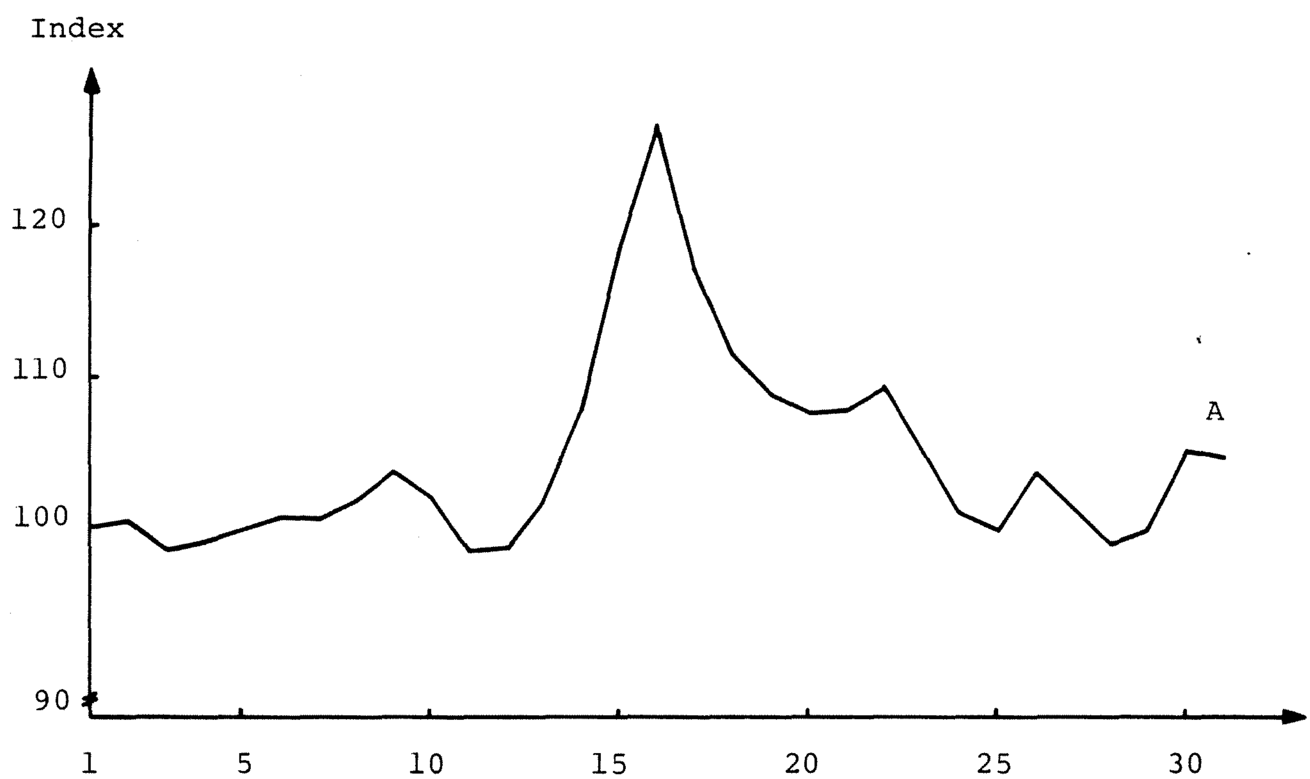
We now assume that each firm experiences a one percent increase in $\alpha$ in new investment, while labor productivity in new investment vintages ($\beta$) increases at a rate 1 percent lower than in the reference case. All other specifications are ceteris paribus. The reader should, however, note that the direct relative output effects on the margin of the change in ($\alpha$, $\beta$) approximately cancel out during the first few years of the simulation. Very soon, however, the dynamics of micro-macro market interaction makes it impossible to control the experiment in such a way that the output effects of the pivoting of technical change are zero.

The simulation results (Figures 5A through D) are quite interesting. For ten years aggregate manufacturing output is the same even though it follows different cycles. By the middle of the simulation a strong export boom sets in. Toward the end of the simulation, however, the reference case has partly caught up with the expansion. Employment is considerably higher, and unemployment very low during the last decade of the simulation, wages are higher, but total investment spending over the 30 year period has been significantly lower than in the reference case. Obviously the relative improvement of "capital productivity" over labor productivity has caused a substitution of labor for capital over the 30 year period studied, which corresponds to the popular notion of the employment consequences of technical change. Two observations should, however, be made. First, the effects are very slow in coming, second, and most important, they are by no means a consequence of the change in the nature of technical progress per se. They have been caused by the relative price and cost consequences of technical change. The reason for the positive employment effects toward the end of the simulation experiment was a controlled wage development (see Figure 5C). The relative increase in output more or less stayed with the capital owners and higher profits did not cause extra wage drift. That higher profits do not necessarily generate faster wage increases also

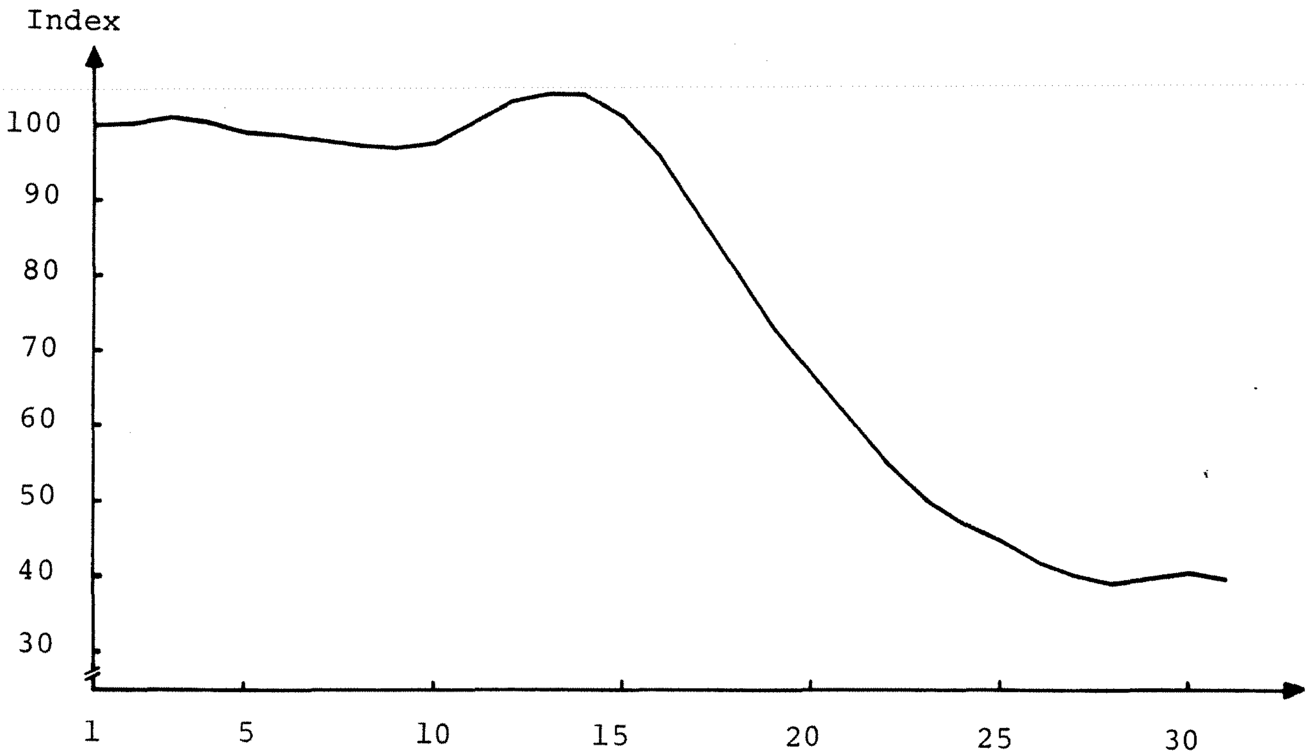
**Figure 5A Manufacturing output, unemployment, wages and investment**

Output neutral (on the margin) pivoting of technical change in a relatively more capital saving direction assumed. Only price elastic export supply behavior exhibited.

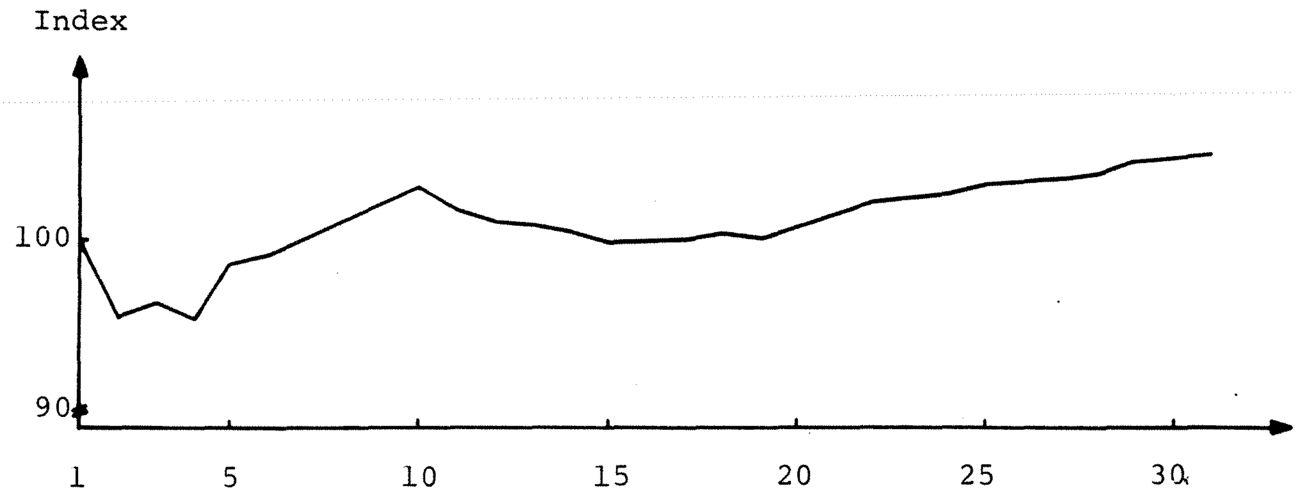
Output



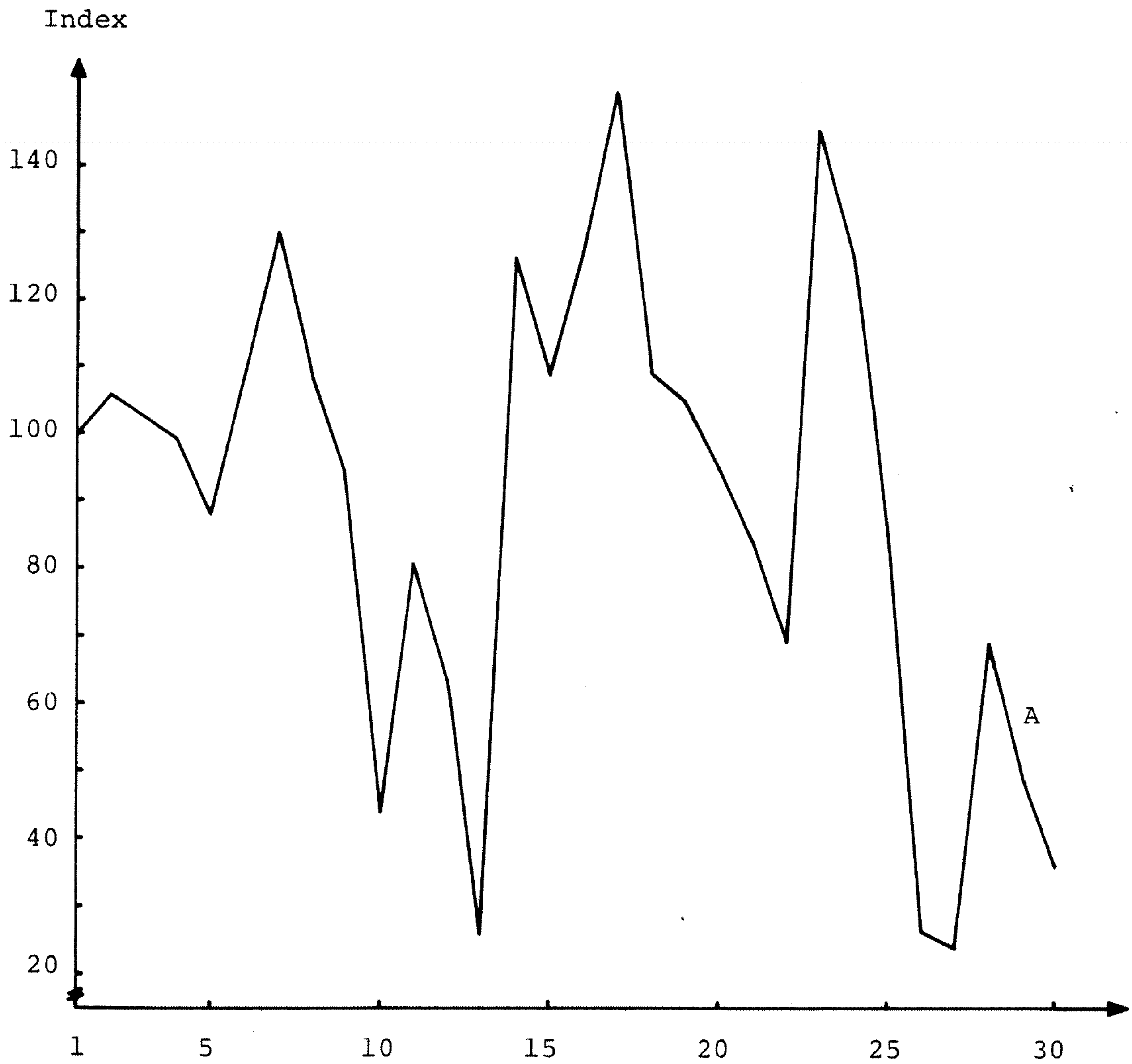
**5B Unemployment**



**5C Wages**



**5D Investment**



appears consistent with empirical evidence (Schager, 1985). The small wage response, this time, appears to have depended on the bad unemployment development in the labor saving technical change scenario. That the employment consequences are ruled by the relative price, cost development and not by the technical change development - if the two diverge - is quite neatly illustrated by the experiments in Figure 3.

### c) **Speed of Adjustment**

Each variation in the technical change assumptions forces structural adaptation on the M-M model economy and results in a different set of final relative prices. The adjustment process is engineered through competitive market processes, the speed of which can be varied.

On this score we note from earlier experimentation on the M-M economy that efficient quantity adjustment of the economy to an exogenous force requires some minimum stability of the corresponding (interactive) adjustment of relative prices. If price and quantity adjustments are too rapid, markets get disorderly, and relative prices jittery. Relative price signals then lose informational content as predictors of future prices, and quantities tend to be less efficiently allocated (E 1983a). If exogenous changes are large enough and market responses fast enough major output collapses can occur.

The market regime specifications in our simulation experiments are the normal ones of the reference case that track historic macro performance reasonably well (E 1983a).

Many of the results observed, however, relate to the micro specifications used. An important, necessary requisite for long-term stable macro development appears to be that micro diversity in the supply structure of the economy is maintained. This is the same as to say that a minimum variation in the ($\varepsilon_i$) in (2) across the firm population is needed each period (E 1984a). The current model set up is particularly sensitive in this respect since it has an endogenous firm exit function while no innovative entry occurs. If the market regime is too fast competition forces too many firms to exit, while the remaining firms are "forced" through factor costs and (endogenous) productivity development to look very much (and too much for stability) alike. The ($\varepsilon$) distributions become flat. As the economy moves closer to a capital market micro equilibrium, the economy grows potentially unstable. (See E 1984a. We are currently working on a realistic entry function to replace the crude one we have. See E 1978a, p. 52ff, and Hanson, 1985.)

## 4 Concluding Remarks on the Role for Government and Other Collective Bodies

Practically all theoretical "results" on the role of the Government in the economy rest on particularly designed economic models that either give an overwhelming role to politicians in office (Keynesian economics) or close to no role at all (pure monetary economics) except a perceived control of money supply. On a separate shelf normative welfare economics resides, framed in static competitive equilibrium theory. The latter world has been designed such that within its logical framework there is no way of demonstrating that a privately organized market economy produces more economic welfare than a centrally planned economy (Pelikan 1985). These results and normative welfare economics in general rest on an axiomatic foundation of theory that imposes simple equilibrium properties on the economic system (E 1983a). More or less, then, standard economic theory lacks a theory of dynamic markets. Once we introduce simultaneous price and quantity setting by agents - as in the M-M model - all the technically nice and for policy makers straightforward and appealing results go away. The policy makers have had a much more demanding job than they ever believed they had in the rosy 60s.

The Schumpeterian-Wicksellian connection explored in this paper is a step in the direction Arrow (1959) asked for. The few, small revisions of received theory, however, both confuse and obscure the standard role of Government in the economic process. When we shift from macro Keynesian, or competitive equilibrium models to M-M dynamics the ability to do - through standard policies - relatively more Good than Harm to the welfare of the citizens of an economy deteriorates drastically. All of a sudden the economic machine becomes too complex for macro demand fine tuning, regulation or redistributional policies, if the objective is to achieve certain, detailed welfare results. A dynamic disequilibrium economic process responds dynamically to policies, and such responses frequently refute original objectives as predicted from received economic theory. The policy conflict lies in the dependence of economic growth on a persistent turnover of monopoly rents in the economy at the micro level. The latter runs counter to the aims of redistributional policies. The interesting thing is, that when such policies are pursued with some success - as apparently was the case in the rosy 60s of Western welfare economics - a measure of instability - released in the 70s (E 1983a) - was introduced by moving the micro structures of the economies closer to static equilibrium conditions, or in simpler words, by reducing all forms of slack in the economies, including cyclical slack.

One conclusion of this paper is that macro productivity change in all its statistical manifestations is a typical economic phenomenon. Pure technical factors may set the upper limits. But the economy is always operating at a significant distance for its potential. Economic and social factors determine how far away, and they operate at the micro market levels. Market dynamics and the ability and willingness of market participants to adjust to change, determine the efficiency of resource allocation and, hence, productivity advance.

Three roles for Government remain after this discourse. The first is close to - but not as extreme as - the monetarist credo, namely to serve as a guardian of an orderly market process. We recognize that in between laissez-faire and extreme intervention there is an optimal degree and form of intervention in the organization of the rules of the market game that enhances the information content of the market process to achieve a steady and more rapid macro economic growth. We note that this role is not that of contracyclical policies. Part of the policy task must be to remove tax wedges in the price system (King-Fullerton, 1984, Södersten-Lindberg, 1984) to remove regulation and union practices etc. that make prices, notably domestic factor prices inflexible and misleading signals for decision makers. This is a form of reversed incomes policy, and the dynamic rationale is that prices cannot be locked in place through incomes policies - except very temporarily - without causing significant negative allocation effects in the longer run.

The second role of Government is that of designing an efficient incentive system. I am thinking not so much in terms of reducing marginal income tax rates to achieve a larger supply of labor hours, but in affecting all the factors that are involved in the creation of new structures - or innovative rents $\varepsilon$ - and that force exit of inferior agents. Economic research has been closing its eyes to these matters since the days of the early Schumpeter - so we simply do not know much about what can be done here. But if I were responsible for an industrial policy arm of a Government, I would feel very uncomfortable with a number of standard bureaucratic procedures, especially those concerned with taking over the jobs of business leaders, and - of course - the subsidy department (E 1984d) and concentrate on establishing a lively and competent experimental base for industry. This issue is partly a matter of attitudes and ideologies of individuals and bureaucrates, and it is fundamentally a matter of education. For an industrial growth engine to function efficiently it must be rewarding in all dimensions of life to engage in the industrial market game. However, even at bureaucratic levels the attitudes have to be properly biased. Curious, risky and experimental purchasing by Government agencies with a view to achiveing a learning experience in industry is probably the most important form of industrial policy. There must be more innovative ways of spending a significant fraction of GNP than on defunct shipyards, standard steel producers and mines.

The <u>third</u> role of Government is technically related to the innovation process. We may imagine that an almost costless redesign of the inovative system may create a tremendous burst of innovative rents, $\varepsilon$. Innovative rents then arise because they are cheap to produce, and they spin off beneficial macro effects in the economy. Something like this appears to have been the case in Swedish industry during the past 10 to 15 years in the sense that the profitability of investing in R&D spending relative to process expansion has increased (see my first paper, E 1985). To a large extent, however, this is the result of previously accumulated knowledge whithin industry and of a rapidly growing supply of well educated engineers. In both ways costs have not been properly charged to the innovative account and technically, shifts in total factor productivity (TFP) are observed.

The classical example of this (third) role is when the Government foots the bill for large infrastructure developments, while output effects are recorded in the private sector. Technically this means that the Government, through its right to tax, deprives labor of part of its income, and sends it back to industry "in kind". However, the Government could of course also organize the labor market such that wage overshooting is prevented, or such that labor is systematically underpaid compared to what they might earn under a different labor market regime (see for instance Chen on Hyper Growth in Asian Economies). The Old Swedish policy model (E 1984b) included typical elements of this, in the sense that centralized bargaining achieved a rather even domestic wage level, such that bad performers could hardly survive and tended to exit, while the high performers in industry paid labor less than they could afford on the margin. This tilted all $\varepsilon$ more in favor of the best performers. The success of policy models like this - for a while - rests on their simplicity (no elaborate intervention on the part of Government in the market processes) and non-transparency to those who are in some sense "exploited" (E 1984).

The Swedish model included an even more subtle parallel element that generated the same positive growth effects - for a while - but that also illustrates how fragile such a policy or price distribution system may be, even though it helps to promote investment and growth. If savers can be fooled into accepting a low return on their deposits a generally higher average $\bar{\varepsilon}$ is created in industry at least for a while. A Wicksellian capital market disequilibrium has been created. We have demonstrated that this directly increases TFP change as we measure it.

Low interest rate policies were typical of European economies in the 50s and early 60s, when domestic credit systems were isolated from one another and could be efficiently regulated. Cheap financing appeared to have lured firms into faster investment expansion than they would otherwise have opted for and possibly more sloppy profitability requirements. This happy situation all of a sudden turned sour when the Western economies found themselves integrated into an international credit market, when interest rates where bid up across the line by the internationally best performers; reducing the "beneficial" $\varepsilon$ effects all over the industrial world. The consequence was that the world capital markets moved closer to what can perhaps be called equilibrium conditions, that capital suppliers (savers) were rewarded at a rate closer to their "just values", that average $\bar{\varepsilon}$ were reduced and - as we have demonstrated above - that total factor productivity growth - as we measure it - vanished.

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